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(54) Adaptive cancellation bridge circuit

(57) The invention relates to an adaptive cancellation bridge circuit (ACB) for use in a single medium full duplex line termination equipment such as modems where signals are transmitted and received simultaneously along a pair of wires, the transmit and receive signal being separated in frequency. The bridge comprises a bridge network including transconductance cells TC1, TC2 and TC3, to provide resistive, capacitive, and inductive components and these cells are electronically controlled by a current control device CC driven from a transmit signal TXS *inphase and quadrature components multiplied* D,E by the receive signal RXS to adjust the bridge network so that it becomes balanced and cancels the transmit signal TXS completely. *with dual, adjustable*

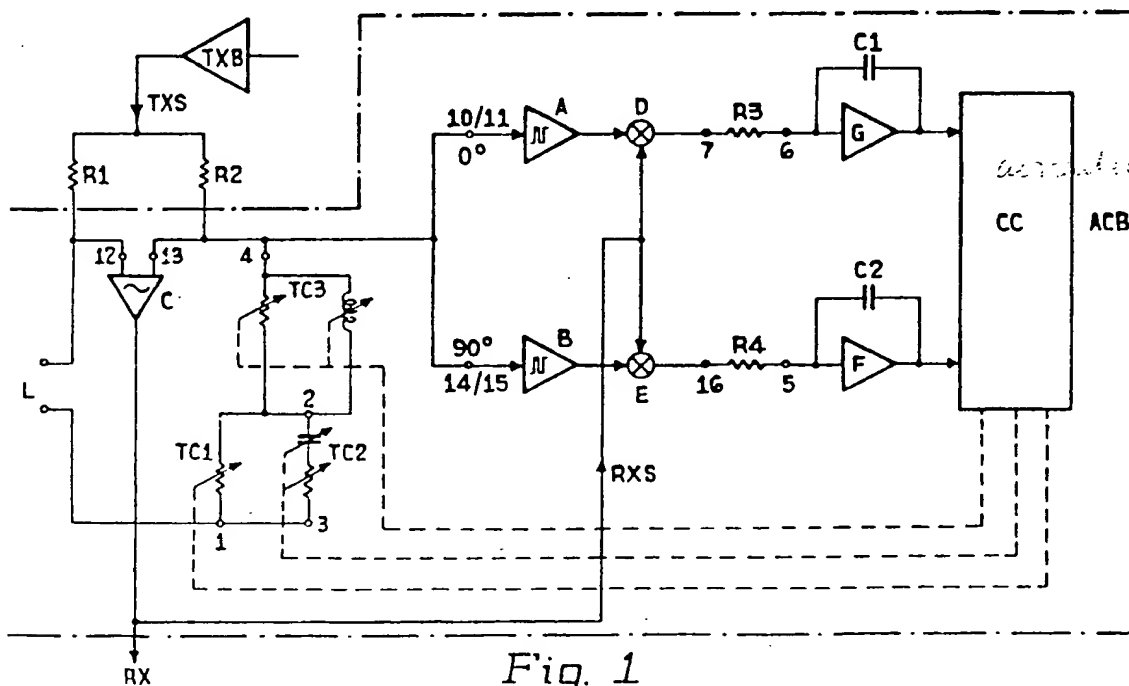


Fig. 1

GB 2 154 836 A

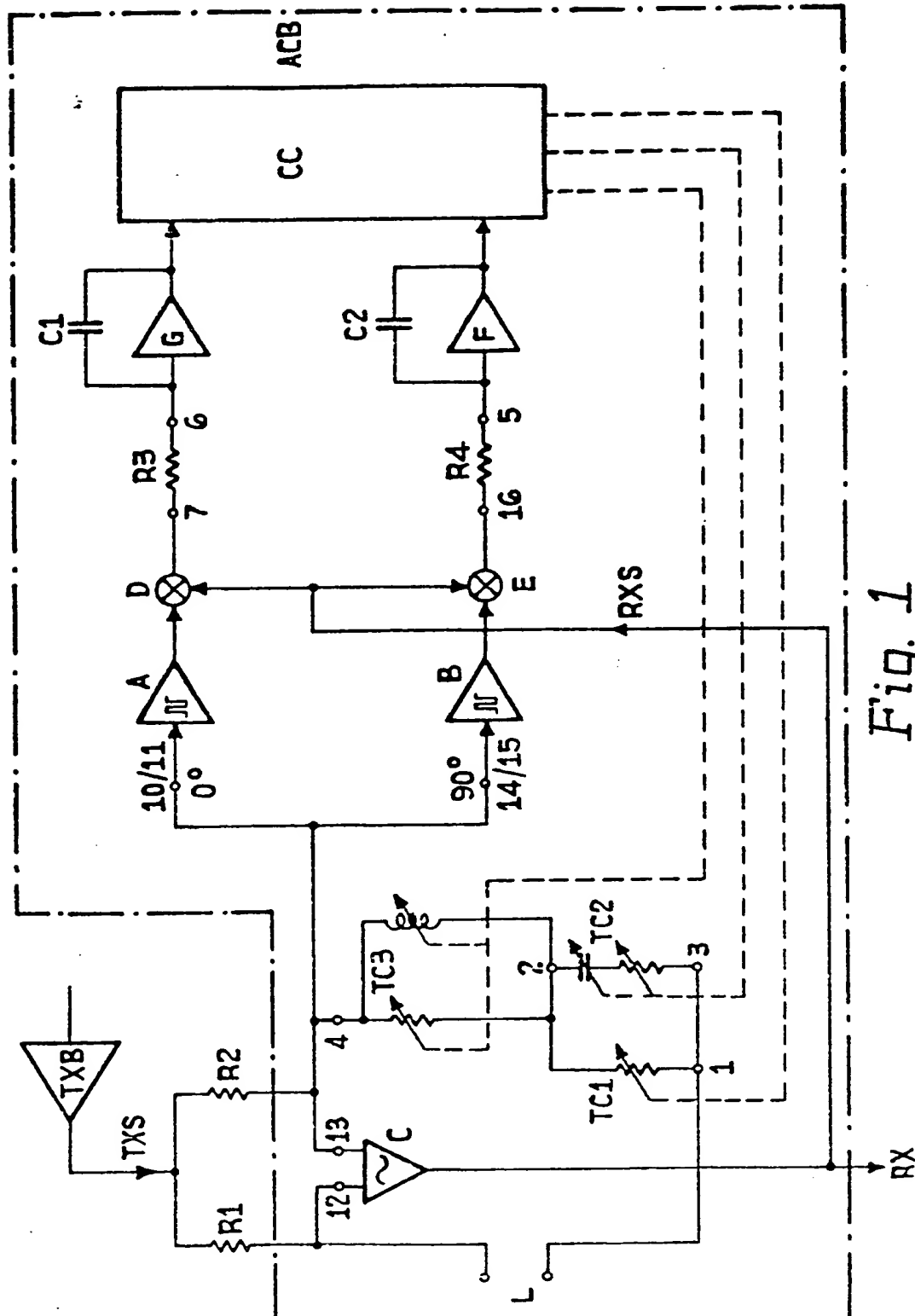
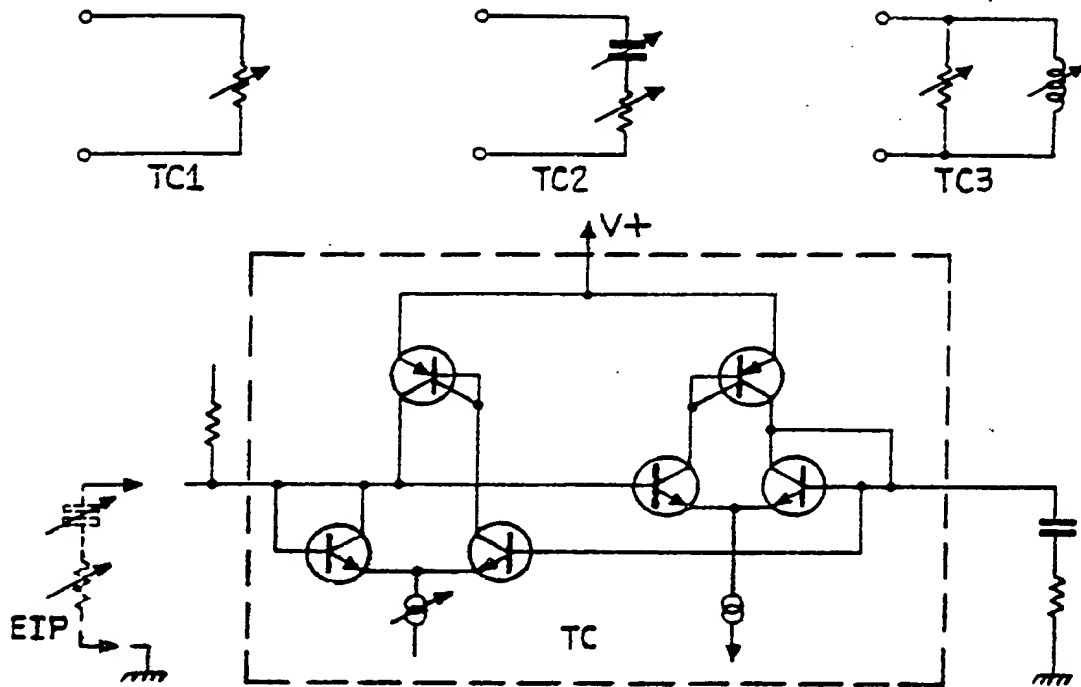
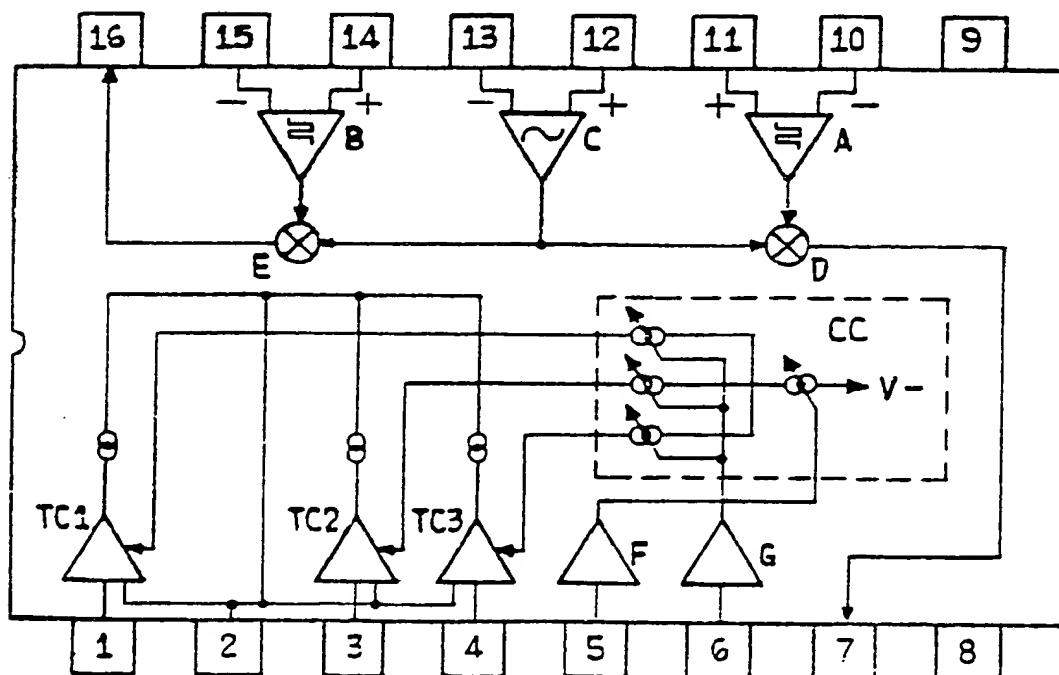


Fig. 1

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Fig. 2Fig. 3

SPECIFICATION

Adaptive cancellation bridge circuit

5 This invention relates to an adaptive cancellation bridge circuit for use in telecommunications systems.

The invention finds particular, although not exclusive, utility in single medium full duplex line terminating equipment such as modems, where signals are transmitted and received simultaneously along a pair of wires, the transmit and receive signals being separated in frequency.

15 When the line attenuation is high the transmitted signal level can be much higher than the received signal level and expensive filtering is required to separate the received signal.

20 This is usually improved by using a bridge or equivalent circuit, of which the transmission line forms one arm. Due to variations in the impedance of the line the improvement obtained is limited—about 10dB is typical.

25 According to the invention there is provided an adaptive cancellation bridge circuit comprising transconductance cells providing resistive, capacitive and inductive components in a bridge network wherein the transconductance cells are controlled by a current control device driven from inphase and quadrature signal components derived from a transmit signal and extracted from the bridge network to adjust the effective resistance, capacitance and inductance of the cells to balance the bridge network, and cancel the transmit signal.

The method to be described uses a bridge network or equivalent circuit in which the resistive and reactive components of one or more of the arms can be electronically varied. Phase sensitive detectors detect components of the transmitted signal in the bridge network output, which can then be automatically nulled out by varying the bridge values.

This greatly improves the effectiveness of the bridge circuit, resulting in improved performance and/or reduced costs, due to simplification of the transmit and receive filter requirements.

The invention will be more readily understood from the following description of an exemplary embodiment which should be read in conjunction with the accompanying drawings in which;

Figure 1 shows an adaptive cancellation bridge according to this invention;

Figure 2 shows the circuit diagram of a transconductance cell, together with a schematic of the impedance of each cell, for use in the adaptive cancellation bridge of Fig. 1; while,

Figure 3 shows lay-out of a typical linear array integrated circuit chip for the arrangement of Fig. 1.

Referring now to the drawings, it should be appreciated that the principle of operation of the adaptive cancellation bridge ACB involves the employment of the transconductance cells TC1, TC2 and TC3 (Fig. 2) in one arm of a bridge network, while another arm is represented by a line L. The other two arms comprise resistors R1 and R2. Each cell is a variable-gain current amplifier which is arranged to produce variable impedances. The equivalent input impedance of such a device is indicated at EIP.

The adaptive cancellation bridge circuit is arranged to separate a received signal RXS from a transmitted signal TXS. To achieve this, the bridge network output is taken to two multipliers A and B used as phase-sensitive detectors to detect the out-of-balance signal components, in phase (0°) and quadrature (90°), derived from the transmit signal TXS transmitted via buffer TXB.

These out-of-balance signals are multiplied by multiplying means at D and E with the received signal RXS, derived from line L, and these multiplied signals are integrated by integrating means R3, C1, G and R4, C2, F respectively. The integrated signals are fed to a current control device CC.

In the current control device, the amplitude of the in-phase component is used to control the overall magnitude of the transconductance cell TC1, TC2 and TC3 control currents, while the out-of-phase, or quadrature, component is used to control a proportion of current applied to each cell.

A 'centre value' of the integrator stage output R4, C, F2 relating to the quadrature component causes most of the current to go to the transconductance cell TC1 which forms the resistive element, and the remaining current to the other two transconductance cells TC2 and TC3. A more positive output with respect to the 'centre value' causes proportionately more current to go to the transconductance cell TC2 which forms the capacitive element whereas a more negative output with respect to the 'centre value' causes proportionately more current to go to the transconductance cell TC3 which forms the inductive element.

Using this technique the bridge network becomes balanced and the transmit signal TXS is completely cancelled.

The integrated chip concerned with the circuit of Fig. 1 is shown in Fig. 3 in which a voltage supply can be connected to terminals 8 and 9.

It is envisaged that an alternative embodiment of the invention could involve in addition to arrangements described, the inclusion of a transconductance cell or cells in a further arm of the bridge network, for instance, in place of or in addition to resistor R2.

It should be understood that although the invention has been devised for use on two-

wire transmission systems, it could also be applied to two-way communication arrangements on other media, such as inductive loops, and with certain limitations, to systems where the transmit and receive signals occupy the same, or overlapping, frequency bands.

Further, an adaptive cancellation bridge circuit including multiple elements and more complex current control loops could be employed for use in wider band systems, for instance, echo cancelling on digital speech circuits.

CLAIMS

1. An adaptive cancellation bridge circuit comprising transconductance cells providing the resistive capacitive and inductive components in a bridge network, wherein the transconductance cells are controlled by a current control device driven from in-phase and quadrature signal components derived from a transmit signal and extracted from the bridge network to adjust the effective resistance, capacitance and inductance components of the cells to balance the bridge network and cancel the transmit signal.

2. An adaptive cancellation bridge circuit as claimed in claim 1, in which the bridge circuit includes at least two phase-sensitive detectors and two multiplying means wherein, one phase-sensitive detector detects the in-phase component and the other phase-sensitive detector detects the quadrature component and wherein, the output signals of the phase-detectors are multiplied by said multiplying means with a received signal derived from a line.

3. An adaptive cancellation bridge circuit as claimed in claim 2, in which the bridge circuit includes a current control device and at least two integrating means for integrating the multiplied signals respectively whereby in the current control device the integrated signal concerned with the in-phase component controls the overall magnitude of the transconductance cell control currents, whereas the integrated signal concerned with the quadrature component controls the proportion of the current applied to each cell.

4. An adaptive cancellation bridge circuit as claimed in claim 3, in which a 'centre value' of the integrator stage output relating to the quadrature component causes most of the current to go to the transconductance cell which forms the resistive element and the remaining current to the other two transconductance cells.

5. An adaptive cancellation bridge circuit as claimed in claim 4, in which when the integrator stage output moves positively with respect to the 'centre value' proportionately more current goes to the transconductance cell which forms the capacitive element.

6. An adaptive cancellation bridge circuit as claimed in claim 4, in which when the

integrator stage output moves negatively with respect to the 'centre value' proportionately more current goes to the transconductance cell which forms the inductive element.

7. An adaptive cancellation bridge circuit as claimed in any of claims 3 to 6, in which current control of the transconductance cells balances the bridge to cancel the transmit signal.

8. An adaptive cancellation bridge circuit as claimed in any one of claims 2 to 7, in which the bridge network includes transconductance cells in at least one arm of the network and a further arm includes the line.

9. An adaptive cancellation bridge circuit, as claimed in claim 1, in which the cells are variable-gain current amplifiers.

10. An adaptive cancellation bridge circuit as claimed in claim 9, in which the variable gain current amplifiers produce variable impedances.

11. An adaptive cancellation bridge circuit as claimed in any one of the preceding claims for use in a single medium full duplex line terminating equipment.

12. An adaptive cancellation bridge circuit substantially as herein described, with reference to and as shown, in the accompanying drawings.

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